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Review

Rehabilitation and return to sport after hamstring strain injury

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Abstract

Hamstring strain injuries are common among sports that involve sprinting, kicking, and high-speed skilled movements or extensive muscle lengthening-type maneuvers with hip flexion and knee extension. These injuries present the challenge of significant recovery time and a lengthy period of increased susceptibility for recurrent injury. Nearly one third of hamstring strains recur within the first year following return to sport with subsequent injuries often being more severe than the original. This high re-injury rate suggests that athletes may be returning to sport prematurely due to inadequate return to sport criteria. In this review article, we describe the epidemiology, risk factors, differential diagnosis, and prognosis of an acute hamstring strain. Based on the current available evidence, we then propose a clinical guide for the rehabilitation of acute hamstring strains and an algorithm to assist clinicians in the decision-making process when assessing readiness of an athlete to return to sport.

Keywords: Acute; Muscle; Performance; Physical therapy; Recurrence; Re-injury; Thigh

1. Introduction

There is a wide spectrum of hamstring-related injuries that can occur in the athlete. These include hamstring strains, complete and partial proximal hamstring tendon avulsions, ischial apophyseal avulsions, proximal hamstring tendinopathy, and referred posterior thigh pain.[1,2] Of these, hamstring strains are the most prevalent hamstring-related injury resulting in loss of time for athletes at all levels of competition.[1–7] Acute hamstring strains often result in significant recovery time and have a lengthy period of increased susceptibility for recurrent injury.[4,8] Approximately one-third of hamstring strains will recur, with the highest risk for injury recurrence being within the first 2 weeks of return to sport.[2,4–9] This high recurrence rate is suggestive of an inadequate rehabilitation program, a premature return to sport, or a combination of both. The consequences of recurrence are high as recurrent hamstring strains have been shown to result in significantly more time lost than first time hamstring strains.[10] Therefore, the purpose of this review article was to provide a summary of the current evidence for clinicians to improve the quality of rehabilitation and decision-making for return to sport after a hamstring-related injury.

2. Epidemiology

There is an increased risk for acute hamstring strains in sports that involve sprinting, kicking, or high-speed skilled movements, such as football, soccer, rugby, and track,[1,4,6–9,11–15] and in sports that involve extensive muscle lengthening-type maneuvers, such as dancing.[1,6,8] Acute hamstring strains have been found to be more common in field sports (football, soccer, and field hockey) than in court sports (basketball, volleyball),[7,9] more common in competition than in practice,[7,13,14] and more common in preseason than regular season and postseason.[7] Most hamstring strains are from non-contact mechanisms[7,14] with the most common mechanisms being running and sprinting activities occurring during sport.[7] Male athletes are 64% more likely to sustain an acute hamstring strain than female athletes.[7,9,12,15]

A National Football League team published injury data, including data from preseason training camp from 1998 to 2007, and found that hamstring strains were the most common muscle strain and were the second most common injury, only surpassed by knee sprains.[13] Hamstring strains were most common in running backs, defensive backs or safeties, and wide receivers.[13] Injury data published from 51 professional soccer teams showed that hamstring strains were the most common injury, representing 12% of all injuries.[14] Track and field injury data from the Penn Relays Carnival showed that hamstring strains were the most common injury, accounting for

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24.1% of all injuries and greater than 75% of all lower extremity strain injuries.[15]

With running and sprinting being the most common activities of hamstring strain injury, identifying the alterations of gait mechanics that may be responsible has received attention. During the terminal swing phase of the running gait cycle, the hamstrings incur the greatest stretch and are active, eccentrically contracting to decelerate the lower limb in preparation for foot contact.[6,16–20] It is important to note that hamstring length is not representative of muscle fiber strain. Fiorentino and colleagues[19] showed that whole-fiber length change relative to the musculotendon unit length change remains relatively constant with increasing speed; however, peak local fiber strain relative to the strain of the musculotendon unit increases with speed, with the highest peak local fiber strain relative to the whole muscle fiber strain occurring at the fastest speed (100% maximum). Peak hamstring force and negative work also occur during this phase, most notably to the biceps femoris, and increase significantly with speed.[16–21] Chumanov and colleagues[16] showed that peak hamstring force and negative work increased to the largest extent as sprinting speed was increased from submaximal to maximal sprinting speeds. The average peak net hamstring force and negative work increased from 36 N/kg and 1.4 J/kg at 80% speed to 52 N/kg and 2.6 J/kg at 100% speed, respectively. Furthermore, Silder and colleagues[22] showed that as speed increased from 80% to 100%, biceps femoris activity during the terminal swing phase increased an average of 67%, while the semimembranosus and semitendinosus showed a 37% increase. The results of these studies offer insights and provide a possible explanation for the tendency of the biceps femoris to be more often injured than the semimembranosus and semitendinosus when running at high speed. In addition, these injuries typically occur along the intramuscular tendon and the adjacent muscle fibers.[6,23]

In sports that involve extreme stretching movements, such as dancing, the semimembranosus is more commonly involved. Injury data published by Askling and colleagues[24] on 15 professional dancers showed that all dancers were injured during slow hip flexion movements with knee extension, with the injury most commonly involving the semimembranosus (87%). More detailed anatomic and biomechanical studies are needed to further investigate the preference of injury to the semimembranosus *vs.* the semitendinosus and biceps femoris. These injuries typically occur more often at the proximal free tendon as opposed to the intramuscular tendon.[2,6,24,25]

3. Risk factors

Acute hamstring strains often result in significant recovery time and have a lengthy period of increased susceptibility for recurrent injury.[4,8] Approximately one third of the hamstring injuries will recur with the highest risk for injury recurrence being within the first 2 weeks of return to sport.[2,4–9] This finding had led some to speculate that athletes may be returning to sport at a suboptimal level of performance due to ineffective rehabilitation or returning to sport prematurely due to inadequate return to sport criteria.[2,4,6,7,11] Several other factors likely contribute to the high rate of recurrent injury, such as persistent weakness in the injured muscle, reduced extensibility of the musculotendinous unit due to residual scar tissue, and adaptive changes in the biomechanics and motor patterns of sporting movements following the original injury.[5,6]

Previous research has identified multiple risk factors for hamstring injury. Non-modifiable risk factors include older age and prior history of hamstring strain.[1,26–32] A prospective cohort study of male soccer players showed that 10.5% of players with a previous hamstring injury and 4.6% of players without a previous hamstring injury experienced a new hamstring injury during the season, indicating that athletes with a prior hamstring injury are at more than twice as high a risk of sustaining a new hamstring injury.[28] Modifiable risk factors include hamstring weakness and fatigue,[31–35] imbalances in hamstring eccentric and quadriceps concentric strength,[34,36,37] decreased quadriceps flexibility,[26] reduced hip flexor flexibility,[26] and strength and coordination deficits of the pelvic and trunk musculature.[4,38–40] It is speculated that addressing each of these modifiable risk factors through rehabilitation programs could potentially decrease re-injury risk. Height, weight, and body mass index have been shown to have no influence on the incidence of hamstring strain injuries.[29,30,41,42]

4. Differential diagnosis

Determining the exact source of injury is critical in determining the most appropriate treatment and expediting safe return to play. Considering the potential causes of posterior thigh pain, the differential diagnosis for acute hamstring strain injury includes hamstring tendon avulsions, ischial apophyseal avulsions, proximal hamstring tendinopathies, and referred posterior thigh pain.

Complete and partial avulsions of the proximal hamstring tendon are uncommon injuries, but can occur during sporting activities that generate forceful hip flexion moments while the knee is extending. Common sporting mechanisms include water skiing,[43–46] bull riding,[44] tackling associated with rugby and football,[47] and slips or falls associated with cross-country and downhill skiing.[46] The athlete may report an audible pop and have significant pain with immediate loss of function. The athlete often presents with an inability or significant difficulty with performing a prone leg curl, an inability to fully extend and bear weight on the involved side, and significant gait abnormality.[44–47] Acutely, significant ecchymosis and a large hematoma are seen in the posterior thigh[46–48] which will likely limit a clinician's ability to discern a palpable defect. In the subacute and chronic phases, once the hematoma has resolved, a palpable defect is often noted with active or resisted knee flexion, which produces a distal bulge in the retracted muscle.[46–48] Another way to assess hamstring tendon integrity in the acute phase is to evaluate for the presence of a positive bowstring sign (absence of palpable tension in the distal hamstring tendons when the knee actively holds a flexed position due to lack of proximal hamstring tendon integrity).[43] Magnetic resonance imaging (MRI) is the most accurate imaging modality for the diagnosis of proximal hamstring avulsions.[46–49]

Ischial apophyseal avulsions are more likely to occur in young athletes (13–16 years) when the apophysis has the least amount of bony bridging or fusion (open growth plate).[49,50] The mechanism of injury typically involves a forceful low-velocity